Chapter 3. Running HAZUS with Default Data

HAZUS contains a variety of default parameters and databases. You can run a loss estimation analysis using only default data, but your results will be subject to a great deal of uncertainty. Default data supplied with **HAZUS** are described in Section 3.5. If you wish to reduce the uncertainty associated with your results, you can augment or replace the default information with improved data collected for your region of study. This chapter will guide you through a very simple analysis using only default data. For more detailed information about collecting and entering additional data or modifying default parameters and data, see Chapters 4 through 8.

Before running a loss estimation analysis you must define a study region. *The Study Region*, in **HAZUS** terminology, is the geographic unit for which data are aggregated, the earthquake hazard defined, and the analysis carried out.

3.1 Defining the Study Region

The study region can be any combination of states, counties, cities, or census tracts. The study region you define will depend upon the purpose of the loss study. In many cases the region will follow political boundaries such as city or county limits. If you are performing a study for a particular city, then the region may include only the area within the city limits. On the other hand, if you are looking at an entire metropolitan area the region may consist of several counties. Defining the study region requires only that you be able to identify the census tracts that comprise the region. However, it is important to note that **HAZUS** will not include any inventory data that you have defined outside the region. In fact, if you include facilities that are located outside the defined study region, **HAZUS** will automatically eliminate these facilities from the inventory databases.

The methodology is based upon using census tracts as the smallest geographic unit. Census tracts are divisions of land that are designed to contain 2,500 to 8,000 inhabitants with relatively homogeneous population characteristics, economic status and living conditions. For this reason the physical area within census tracts will vary depending on the density of the population. In densely populated regions census tracts can be a few city blocks, whereas in rural areas a census tract may be many square miles. Census tract divisions and boundaries change only once every ten years. Census tract boundaries never cross county boundaries; hence census tracts can completely and uniquely define all the area within a county. This characteristic allows for a unique division of land from country to state to county to census tract. Note, however, that a census tract can cross city boundaries. A unique 11-digit number identifies census tracts. The first two digits represent the tract's state; the next three digits represent the tract's county, while the last 6 digits represent a number that identifies the tract within the county. For example, a census tract numbered 10050505800 would be located in Delaware (10) in Sussex County (050).

You have the flexibility to define any arbitrary study region by selecting a set of census tracts. The study region may overlap multiple states and counties and may contain only portions of counties or cities. You can define any number of study regions (limited only by disk space), and can switch between them at any time. Each study region has its own

copy of the inventory data that can be edited/modified independently from other regions. The steps you will use to define the study region are summarized in Figure 3.1.

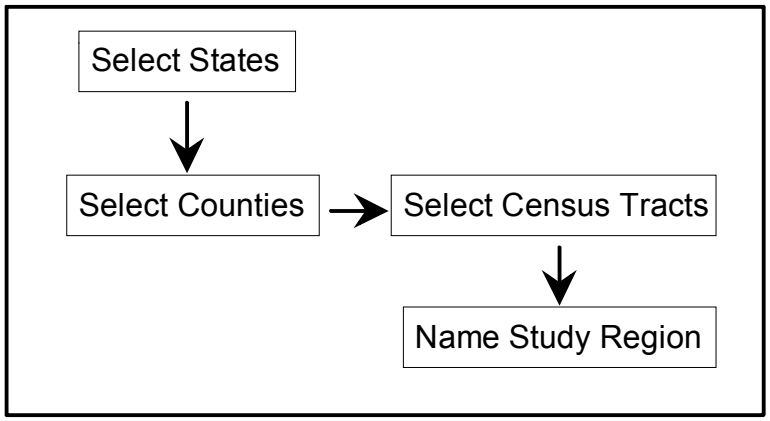


Figure 3.1 Steps needed to define the study region

When using **HAZUS**, you will create a study region by the following sequence. From the **Study Region** window select **Create** and **New Region** as shown in Figure 3.2. In order to create a new study region the CD-ROM must be in the CD drive. The **Study Region** window will appear automatically when **HAZUS** is launched. The window also can be displayed by selecting the **File|Region** menu option.

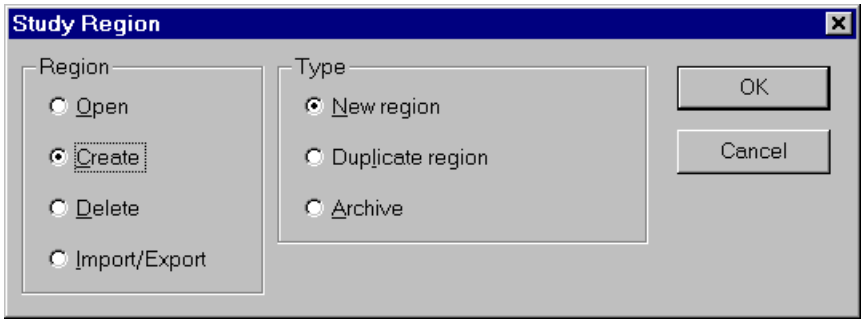


Figure 3.2 HAZUS study region window

Next you will be prompted to select which states (including portions of states) are included in the study region. To select a state, simply click on the name of that state. To select multiple states, hold down the **Ctrl** key while you click on all of the states you wish to include. The user has selected Oregon in the example shown in Figure 3.3. It is important to make sure that you have enough disk space before you start the aggregation. The minimum recommended size is 1 GB. **HAZUS** displays the disk space available for aggregation as shown in Figure 3.3 (in this example, the available space is approximately 1.4 GB). When you have finished selecting the states, click on the **Next>** button.

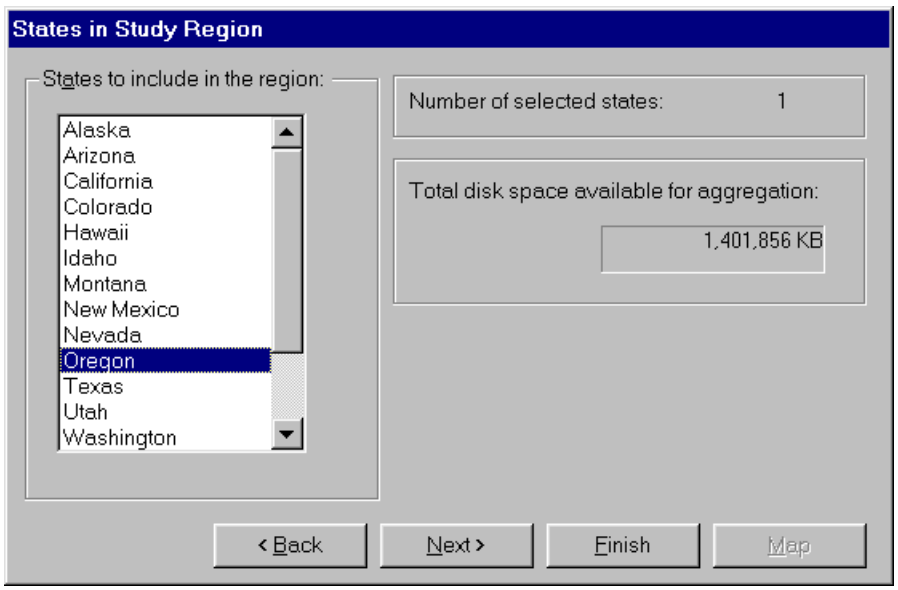


Figure 3.3 HAZUS state selection window

Once you have selected the states and clicked the **Next>** button, all of the counties in the selected states will be displayed. You can then select which of the counties you wish to include in the study region by clicking on the names of those counties. Multiple counties can be selected by holding down the **Ctrl** key and clicking on the desired counties as shown in Figure 3.4.

Alternatively you can click the **Map** button and choose the counties from a map of the state as shown in Figure 3.5. To select multiple counties, hold down the **Shift** key while clicking on the desired counties. When done, pull down the **Select** menu and choose **Selection Done**. This will return you to the window shown in Figure 3.3. Note that **Selection Done** is the only valid option from this window and you should not try to close the map using **File|Close|Table** option.

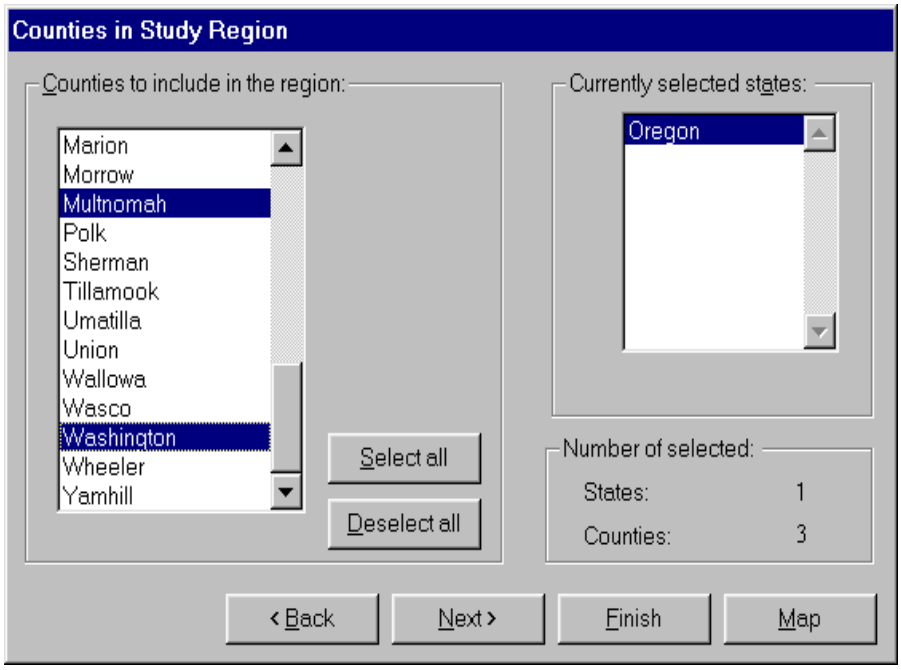


Figure 3.4 HAZUS county selection window

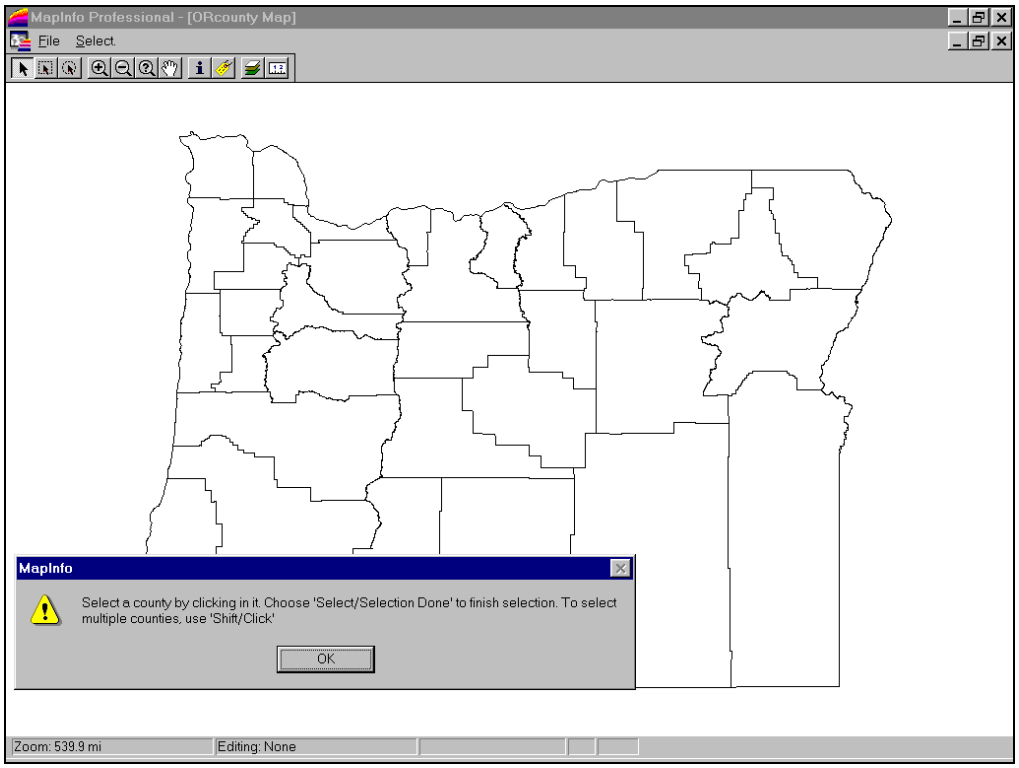


Figure 3.5 Selection of counties using the Map option

Once you have selected the counties and clicked on the **Next>** button, you will be presented with all of the census tracts in the selected counties as shown in Figure 3.6.

You can then select the census tracts that define the study region. At any point in this process you can undo your selections by using the **<Back** button.

At any point in state, county or census tract selection, you can click on **Finish** and you will have automatically selected everything within the previously selected entity. For example, if the user were to click **Finish** after he had selected Oregon in Figure 3.3, he would have selected all the counties in Oregon.

In this example the user has selected 234 census tracts from the three Oregon counties. The census tracts do not have to have continuous numbering nor do they need to be contiguous. As with the other windows you may graphically select census tracts by using the **Map** button. The selection of census tracts directly from the map is mostly helpful in the case of choosing census tracts that are in the vicinity of a city but not in a numerical sequence, or for the case when the location of a city is known while the census tract numbers around that city are not known.

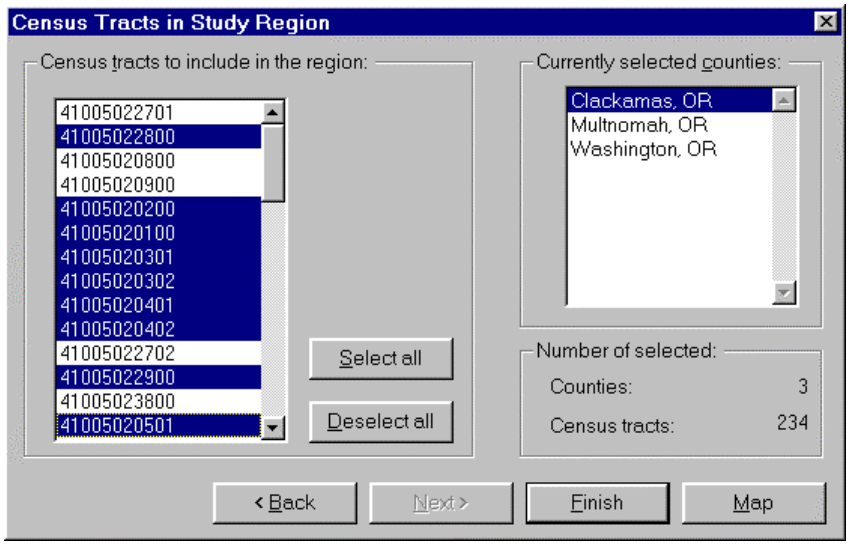


Figure 3.6 HAZUS census tract selection window

When you have selected the census tracts, click on the **Finish** button and you will have the opportunity to name the study region and store it for future use (see Figure 3.7). The **Study Region description** is a more complete description of the study region that is used for display purposes in **HAZUS**. The **Study region folder/directory** is used to identify the directory (e.g. C:\HAZUS\PRTLND) where all data and results are kept.

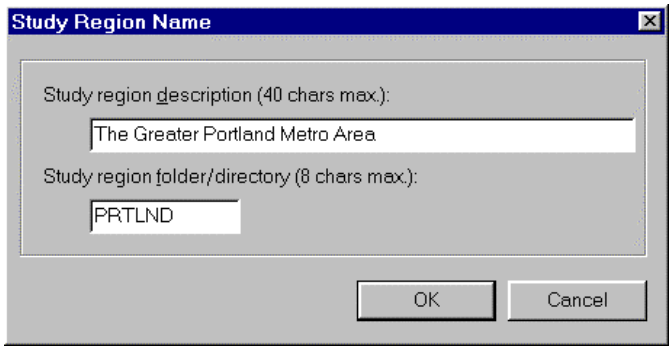


Figure 3.7 HAZUS study region name window

After clicking on the **OK** button you will have to wait a few minutes while the default inventory data are downloaded from the CD-ROM to your hard drive. When that process is complete, a map of the study region, such as the one shown in Figure 3.8, will appear. Once a study region is created it can be retrieved and used for any number of analyses. Using the Open selection option shown in Figure 3.2 the user can retrieve a region.

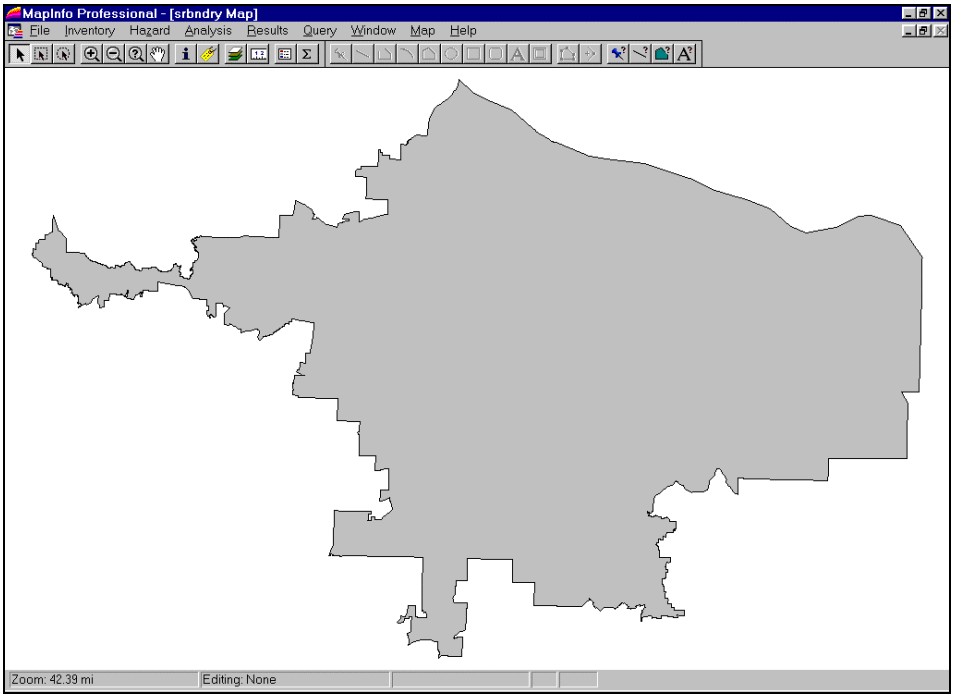


Figure 3.8 Map of a study region

3.2 Defining a Scenario Earthquake

Before an analysis can be run, you must quantify the potential earth science hazards (PESH) that will serve as a basis for evaluating damage and losses. For an earthquake loss analysis, this involves identifying the size and location of the earthquake and estimating its associated ground motions and ground deformations due to ground failure.

For this methodology, ground deformations due to liquefaction, landslides, and surface fault rupture can be included.

While there are a number of options available for defining PESH (see Section 9.1), the only method described in this section is defining a scenario earthquake using the arbitrary event option.

Click on the hazard definition menu (**Hazard**) as shown in Figure 3.9. Clicking on the **Scenario** option allows you to define the earthquake hazard using the window shown in Figure 3.10.

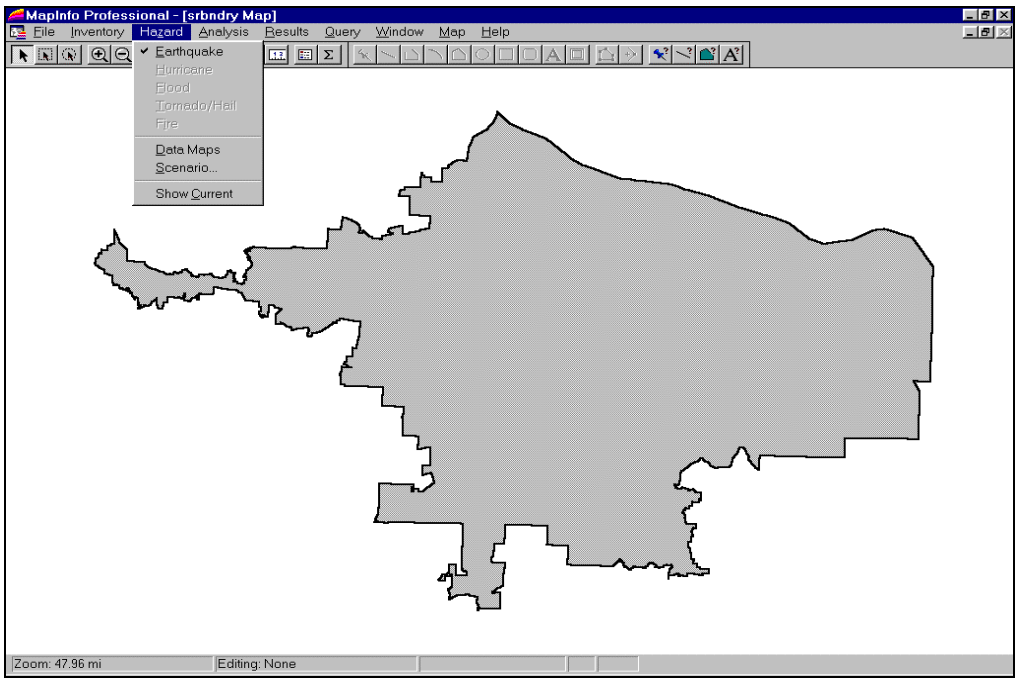


Figure 3.9 Hazard definition menu in HAZUS

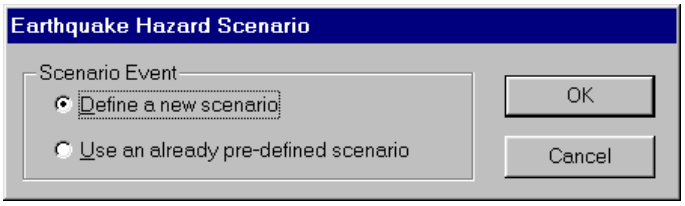


Figure 3.10 HAZUS Earthquake Hazard Scenario window

Choose **Define new scenario event** and the window shown in Figure 3.11 will appear. The **Use an already pre-defined scenario** button can be used only if you have previously run a scenario for this region.

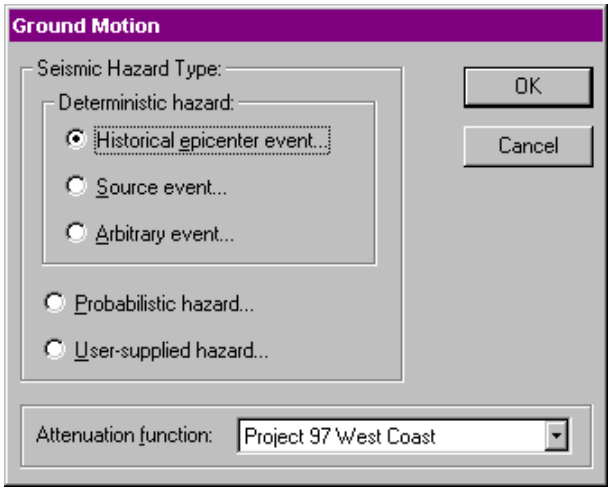


Figure 3.11 HAZUS Ground Motion definition window

Next, click on **Arbitrary event…,** accept the default attenuation function *Project 97 West Coast*[4] by clicking **OK**, and supply the parameters shown in the window in Figure 3.12. At a minimum, you need to supply the latitude and longitude of the event. Without any additional input from you, **HAZUS** will default to a 7.0 moment magnitude with a corresponding surface and subsurface rupture length, a default depth in kilometers, a fault rupture orientation of 0 degrees and a strike-slip fault type. Entering data in the appropriate places can change any of these defaults.

You can select the latitude and longitude from a map of the region by clicking on the **Map** option. You will be prompted to select a point in the study region by clicking on the screen. Once you have done this, **HAZUS** will return you to the window in Figure 3.12.

[4] HAZUS implements 7 attenuation functions for the Western U.S. regions, and 3 for the East Coast. The list showing in the combo-box will vary according to the study region aggregated.

For West Coast, the functions are:

- Project 97 West Coast,
- Project 97 Pacific Northwest
- Project 97 Hawaii
- Boore, Joyner & Fumal (1994)
- Sadigh et. al. (1993)
- Youngs et. al. (1995)
- Munson & Thurber

For East Coast, they are:

- Project 97 East Coast
- Frankel (1996)
- Toro, Abrahamson & Schneider (1994)

Chapter 5 of the technical manual describes in detail all of the functions listed above.

If you choose to change the magnitude and would like to have the surface and subsurface rupture lengths correspond to the new magnitude, you need to click on the **Override** boxes. When you have finished, click on the **OK** button.

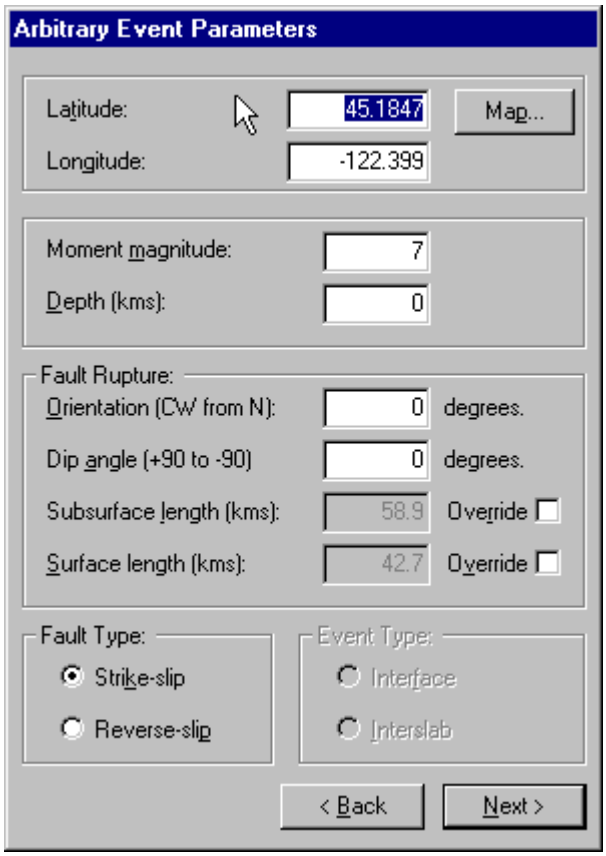


Figure 3.12 Window to define parameters for an arbitrary event

3.3 Running an Analysis Using Default Data

If you opt to run your analysis with default data and parameters, the only information you will need to supply **HAZUS** is the definition of the study region and the size and location of the scenario earthquake. Defining the study region was discussed in Section 3.1 and definition of the scenario earthquake was outlined in Section 3.2. Once this information has been supplied the analysis can be run using the following steps:

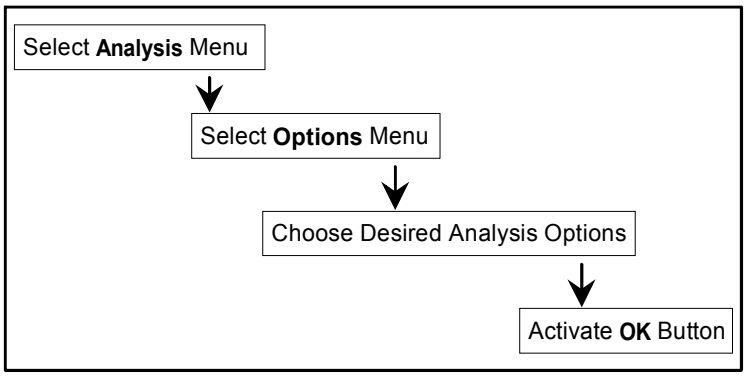


Figure 3.13 Running an analysis with HAZUS

The **HAZUS** windows used to perform this sequence of steps are illustrated in Figures 3.14 to 3.19. Figure 3.14 shows the **Analysis** menu. This menu can be accessed after you have defined the study region and the scenario event. The map shown in Figure 3.14 is an outline of the study region that was created using the steps detailed in Section 3.1.

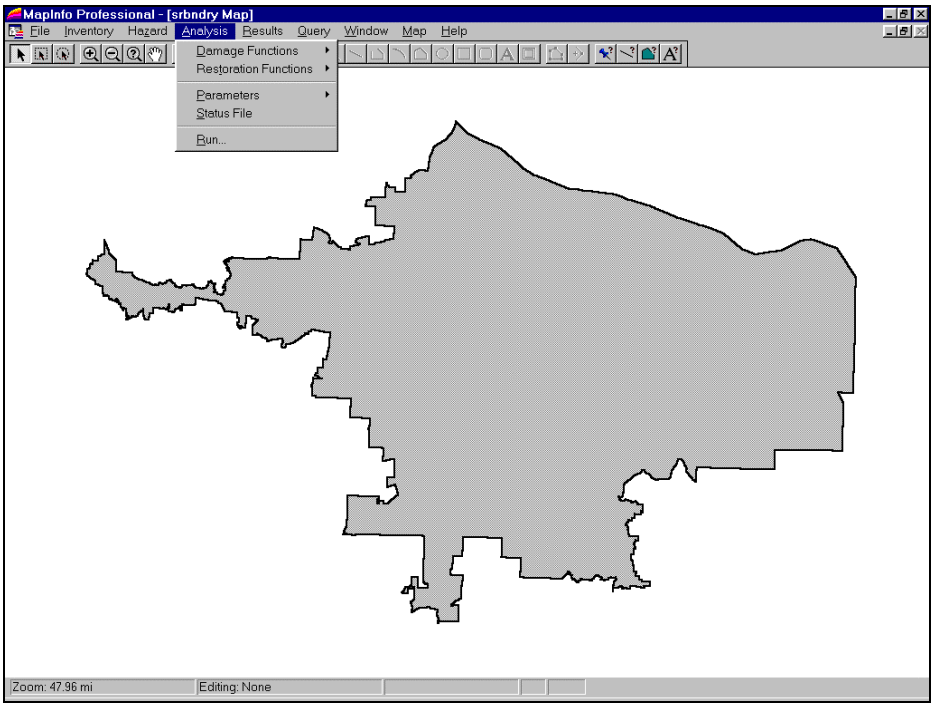


Figure 3.14 Accessing the HAZUS Analysis menu

There are several operations within the **Analysis** menu that can be initiated, such as modifying damage functions or restoration times. However, you can run an analysis using only default data and inventory, without modifying any parameters whatsoever. Choose the **Run...** option and the window in Figure 3.15 will appear. This window provides a number of analysis options that can be selected by clicking in the associated box. There are branches under each analysis option. To select all branches under an analysis option for analysis, click on the box beside the analysis item. Figure 3.15 is an example of an analysis scenario where all the options under the **PESH** module are to be

analyzed. To unselect some of the analysis branch under the main analysis option, click on the + sign next to the analysis option and all branches of the analysis options will be displayed (as shown in Figure 3.16). The window shown in Figure 3.16 allows you to select in detail the type of analysis and output that you would like to perform. Select all the analysis branches that you would like to be included by clicking on the box next to each item. If you select all branches under an analysis option, the box next to the analysis option will be white with a check mark inside it. If you only select a limited set of branches, the box will be gray with a check mark inside it as shown in Figure 3.15 through 3.19.

It is important to note that analysis branches might have sub and sub-sub branches (as shown in Figure 3.16) and the same rule of selecting and un-selecting apply to all of them. Items that have branches are typically indicated by a + box next to the analysis option. Once a particular analysis option has been expanded, the + sign next to it turn to a – sign. A branch with no sub-branches has no + or – sign next to it.

All analysis options can be run at the same time or each can be run separately. If a study region is small, use the right mouse click and select the **Select all module**[5] to select all analysis options for analysis. If a study region is large (a few hundred to more than a thousand census tracts), a complete analysis can take several hours. It is suggested that you run the analysis options one at a time while you are developing and modifying scenarios, inventories, and model parameters. This allows you to review intermediate results and check to determine if the results look reasonable or serve your needs without waiting several hours to run a complete analysis. Once you are satisfied with inventories and model parameters, you may wish to perform additional analyses with all options running simultaneously.

If you wish to ask "what if" questions, individual options can be run repeatedly without performing a complete analysis. Once an option is run, all of the results from that option are saved until it is run again. For example, if a you want to know what would happen if costs of repairs were increased (keeping everything else the same), you would only have to run the **Direct social and economic loss** option again. **HAZUS** will use damage results from the previous analysis to estimate economic losses.

[5] Or simply click the **Select All** button.

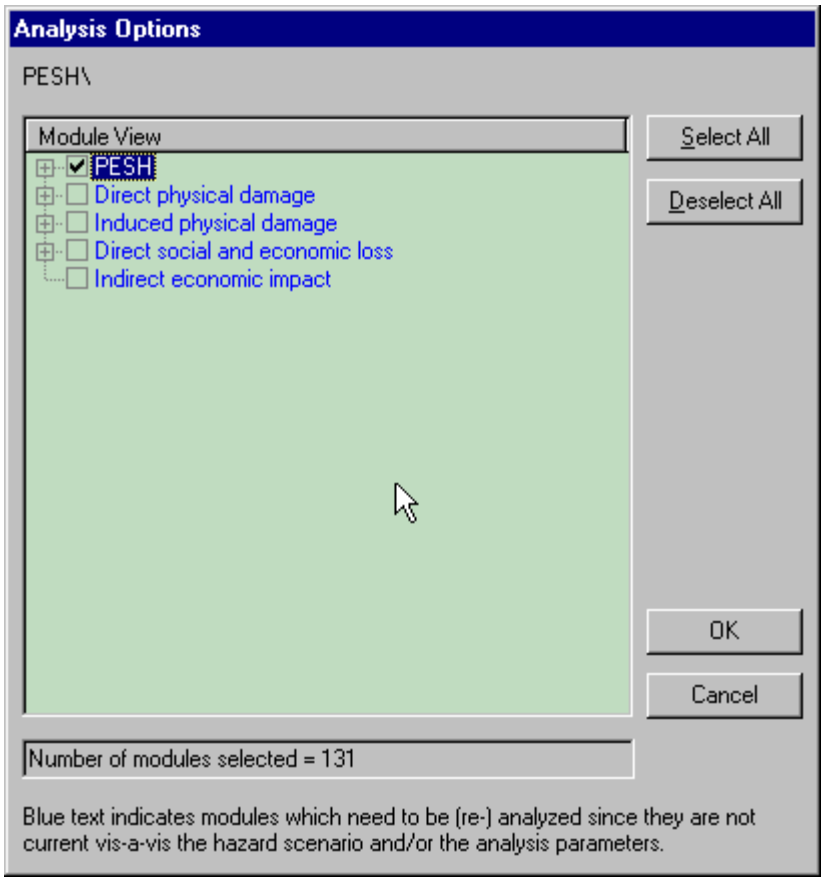


Figure 3.15 Analysis Options window in HAZUS

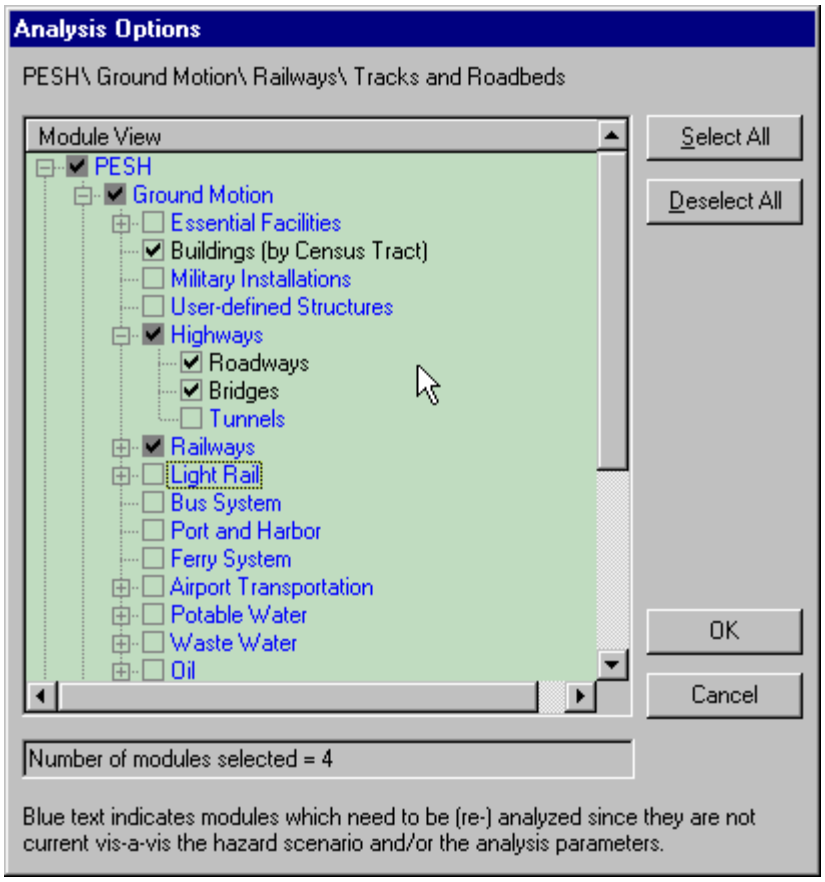


Figure 3.16 PESH analysis options window

All loss estimation analyses must run the **PESH** option at least once since the PESH module defines the ground motion that is used to estimate damage and loss. The Analysis Options provides you with the opportunity to specify exactly which damage and losses you want to estimate. For example if you select the **Direct physical damage** option as shown in Figure 3.17, you may opt to estimate damage to general building stock, highways and railways by checking the box next to these facilities. (Note: To select all facilities under one kind of facility's type, check the box beside the branch's root) You may specify **Debris** only from the **Induced Physical Damage** and **Casualties** from the direct social and economic loss as shown in Figures 3.18 and 3.19. There are numerous combinations of analysis options designed to enable you to run as limited or as broad of an analysis as you wish. Once all of the desired options have been specified, click on the **OK** to run the analysis.

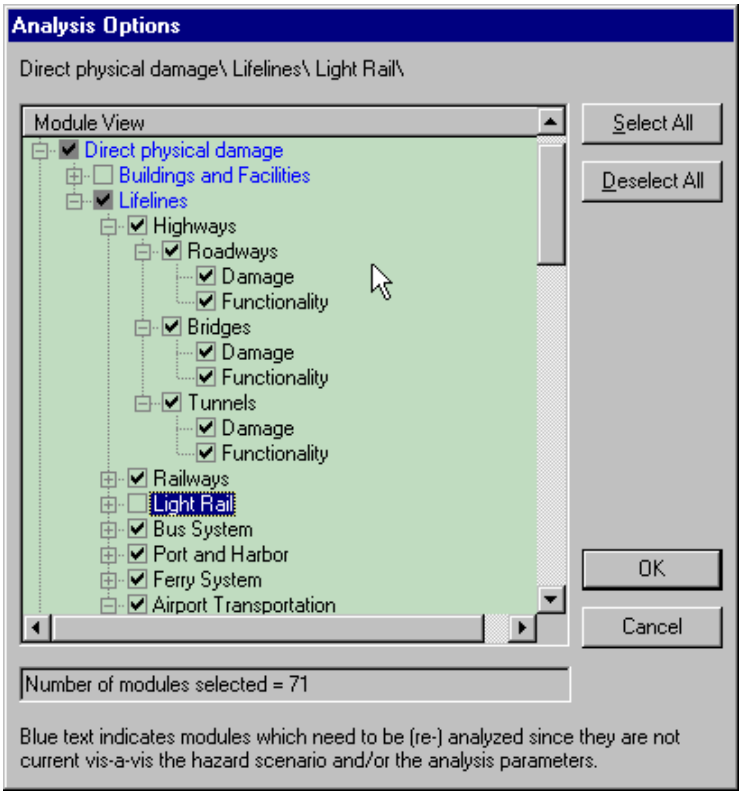


Figure 3.17 Direct physical damage analysis options window

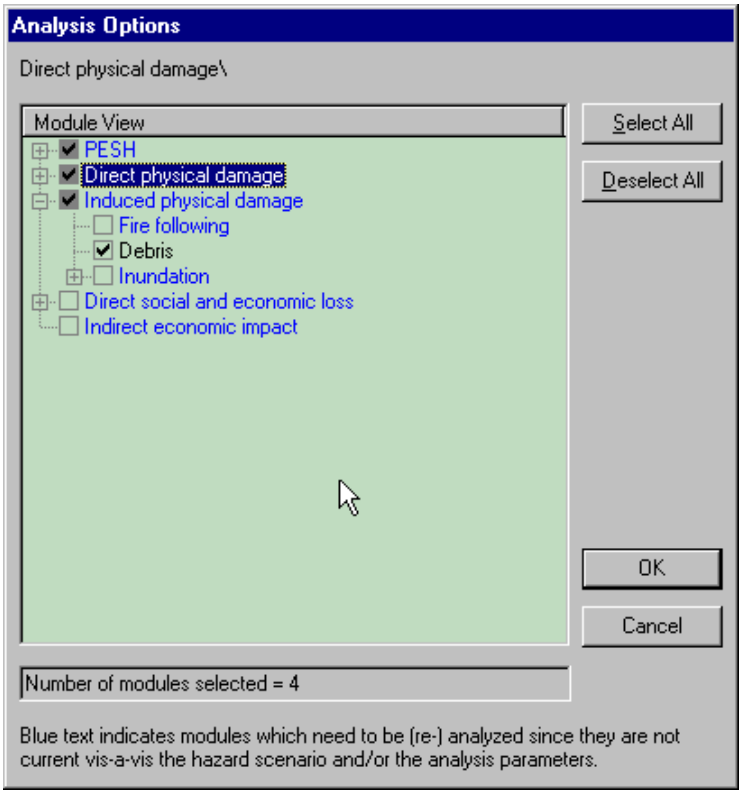


Figure 3.18 Induced physical damage analysis options window

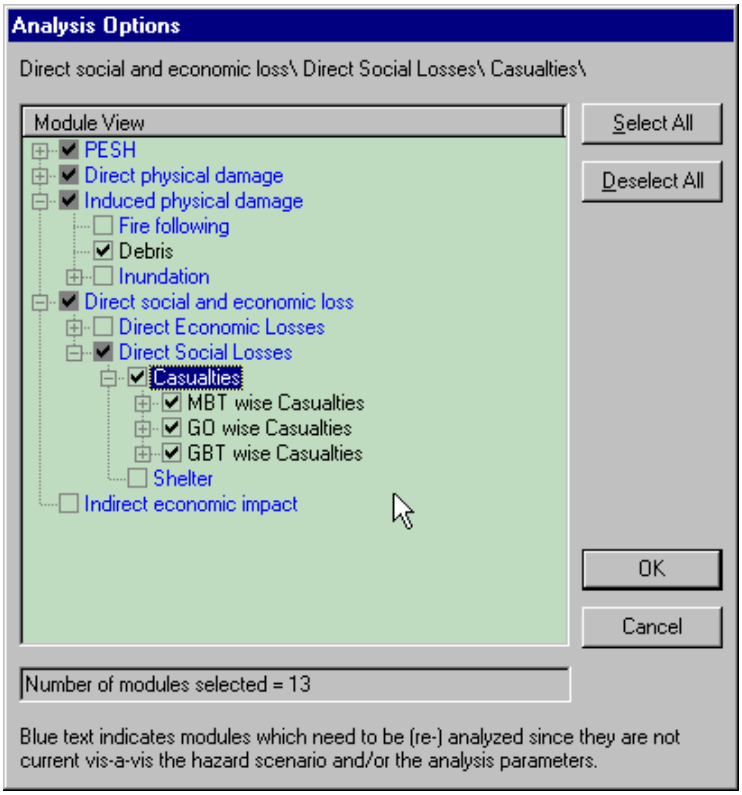


Figure 3.19 Direct social and economic loss options window

The Analysis Option dialog has a sophisticated built-in algorithm to keep track of the dependencies between the different modules in **HAZUS**. For example, to calculate the direct physical damage to buildings, the ground motion has to be calculated first. To ensure the integrity of the analysis, when a module is selected, all the dependent modules are selected automatically.

3.4 Viewing Analysis Results

Each of the modules of **HAZUS** provides the user with a series of outputs. The outputs can be in a numerical or graphical form. Some of the modules yield intermediate results that are used as inputs to other modules. For example, the PESH (Potential Earth Science Hazards) module determines ground motion at different locations for a specified earthquake scenario. This information by itself may not be very useful for hazard mitigation and emergency planning. However, the results of the PESH module are used as an input to determine the damage to structures in the Direct Physical Damage module.

Analysis results are accessed from the **Results** menu as shown in Figure 3.20. Three types of output are available:

- Thematic map of results (Figures 3.21 and 3.22)
- Table of results by census tract (Figure 3.23)
- Summary table of results by county and for the whole region (Figure 3.24)

Thematic maps use colors or symbols to display of results. For example in Figure 3.21, crosshatched area might indicate 20% to 25% of the census tract is burned and dotted

area might indicate 0% to 4% is burned. Similarly in Figure 3.22, a circle indicates a high probability of an airport terminal being functional and a triangle indicates it is more likely to be non-functional. Results can be thematically mapped by using the **Map** button at the bottom of a table of results (see Figure 3.23). A variety of summary reports are available through the **Summary Reports** menu at the bottom of the **Results** menu shown in Figure 3.20. Displaying results is discussed in more detail in Chapter 10.

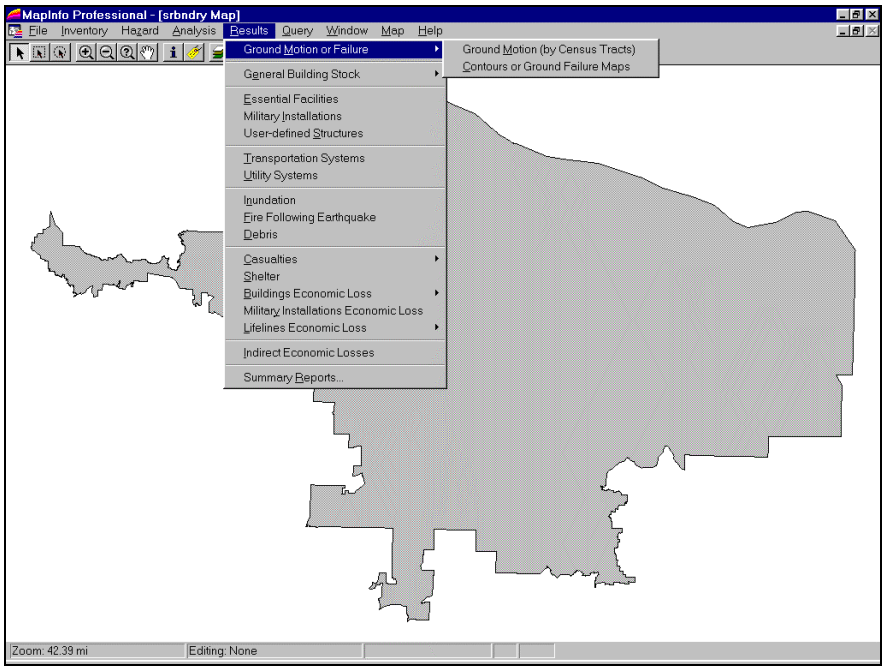


Figure 3.20 Accessing analysis results

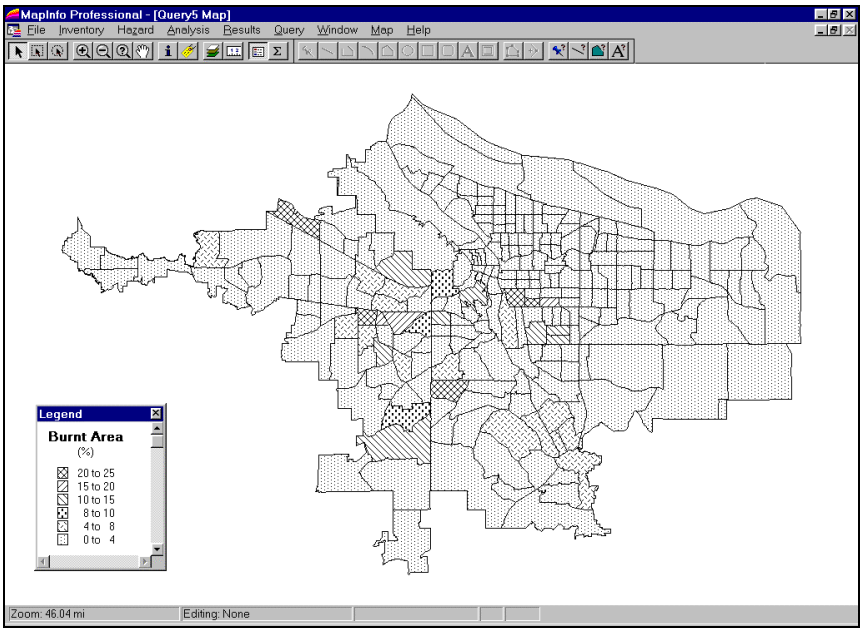


Figure 3.21 Sample thematic map: percent of each census tract burned

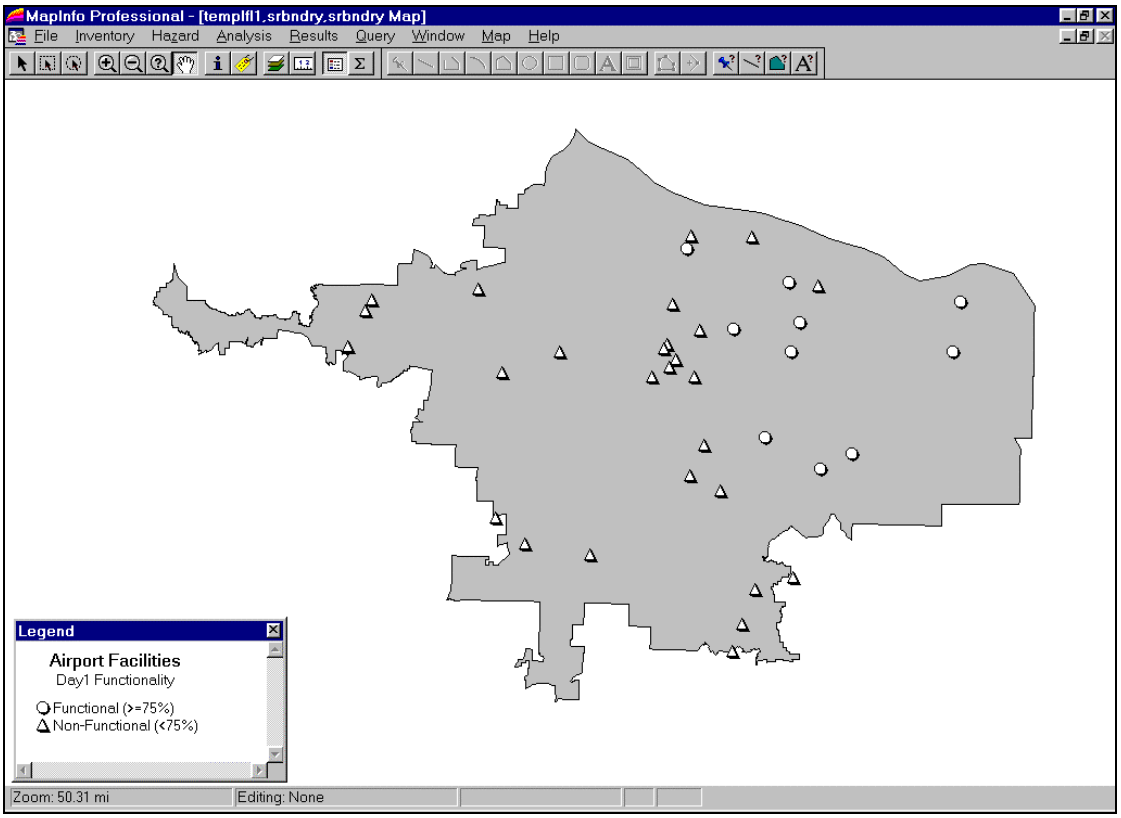
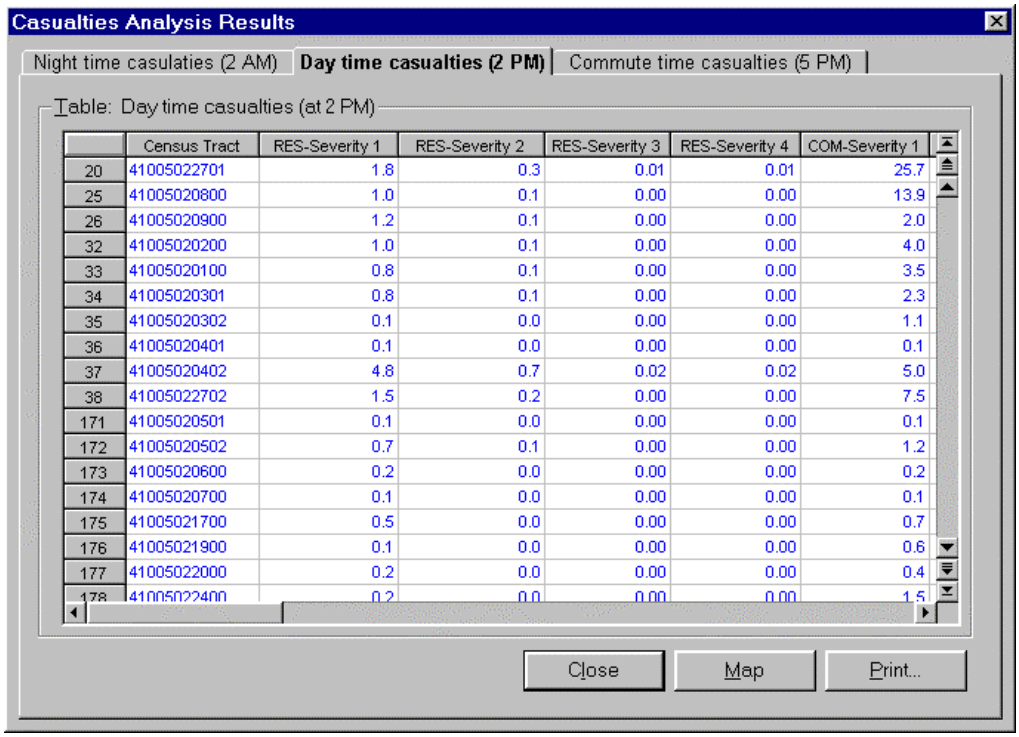
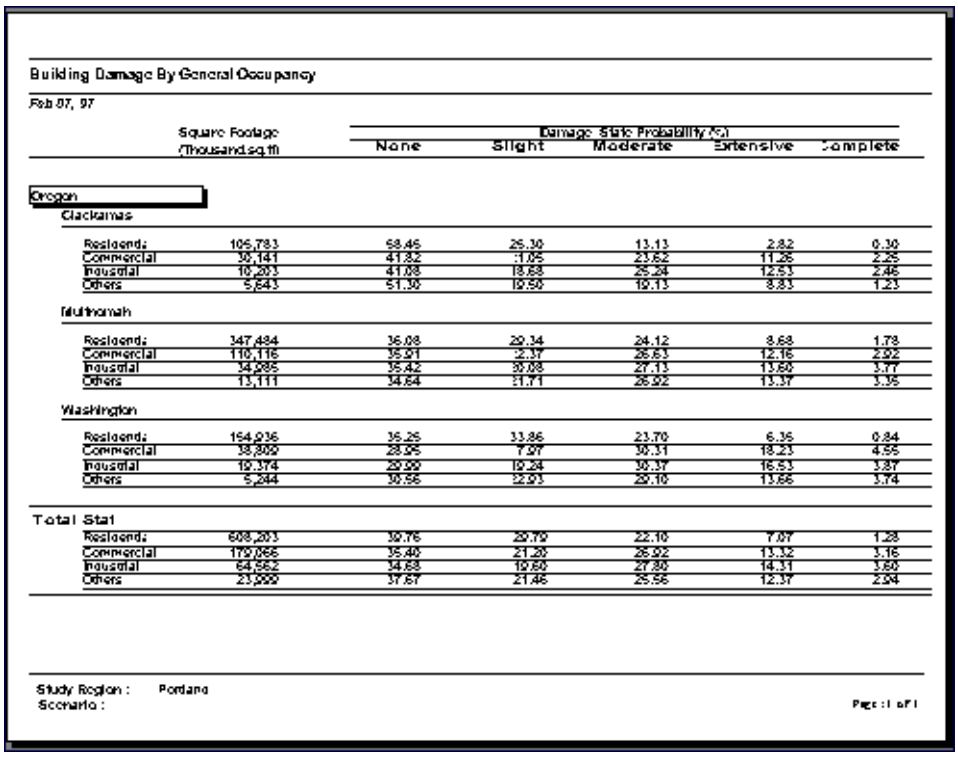


Figure 3.22 Sample thematic map: functionality of airport terminal buildings



	Census Tract	RES-Severity 1	RES-Severity 2	RES-Severity 3	RES-Severity 4	COM-Severity 1
20	41005022701	1.8	0.3	0.01	0.01	25.7
25	41005020800	1.0	0.1	0.00	0.00	13.9
26	41005020900	1.2	0.1	0.00	0.00	2.0
32	41005020200	1.0	0.1	0.00	0.00	4.0
33	41005020100	0.8	0.1	0.00	0.00	3.5
34	41005020301	0.8	0.1	0.00	0.00	2.3
35	41005020302	0.1	0.0	0.00	0.00	1.1
36	41005020401	0.1	0.0	0.00	0.00	0.1
37	41005020402	4.8	0.7	0.02	0.02	5.0
38	41005022702	1.5	0.2	0.00	0.00	7.5
171	41005020501	0.1	0.0	0.00	0.00	0.1
172	41005020502	0.7	0.1	0.00	0.00	1.2
173	41005020600	0.2	0.0	0.00	0.00	0.2
174	41005020700	0.1	0.0	0.00	0.00	0.1
175	41005021700	0.5	0.0	0.00	0.00	0.7
176	41005021900	0.1	0.0	0.00	0.00	0.6
177	41005022000	0.2	0.0	0.00	0.00	0.4
178	41005022400	0.2	0.0	0.00	0.00	1.5

Figure 3.23 Sample tables of results: residential casualties at 2 PM



Building Damage By General Occupancy

Feb 07, 97

	Square Footage (Thousand sq ft)	Damage State Probability (%) None	Slight	Moderate	Extensive	Complete
Oregon						
Clackamas						
Residential	105,783	58.46	26.30	13.13	2.82	0.30
Commercial	38,141	41.82	31.05	23.62	11.26	2.25
Industrial	10,203	41.08	18.68	26.24	12.53	2.46
Others	5,643	51.36	19.50	19.13	8.83	1.23
Multnomah						
Residential	347,484	36.08	29.34	24.12	8.68	1.78
Commercial	110,116	35.01	32.37	26.63	12.16	2.92
Industrial	34,085	35.42	30.08	27.13	13.60	3.77
Others	13,111	34.64	31.71	26.92	13.37	3.36
Washington						
Residential	164,936	36.26	33.86	23.70	6.36	0.84
Commercial	58,809	28.05	7.97	30.31	18.23	4.55
Industrial	19,374	29.99	19.24	30.37	16.53	3.87
Others	5,244	30.56	22.93	29.10	13.66	3.74
Total Stat						
Residential	608,203	39.76	29.79	22.10	7.07	1.28
Commercial	179,066	35.40	21.20	26.92	13.32	3.16
Industrial	64,562	34.68	19.60	27.80	14.31	3.60
Others	23,999	37.67	21.46	25.56	12.37	2.94

Study Region : Portland
Scenario :

Figure 3.24 Sample summary report: building damage by general occupancy

3.5 Default Databases and Default Parameters

While most users will develop a local inventory that best reflects the characteristics of their region, such as building types and demographics, **HAZUS** is capable of producing crude estimates of losses based on a minimum of local input. Of course, the quality and uncertainty of the results will be affected by the detail and accuracy of the inventory and the economic and demographic data provided. The crude estimates would most likely be used only as initial estimates to determine where more detailed analyses would be warranted. This section describes the types of data that are supplied as defaults with **HAZUS**.

3.5.1 Default Databases

Default inventory databases provided with **HAZUS** are of two types. The first type is a national listing of *individual* facilities, such as dams, bridges, or locations where toxic materials are stored. These databases are modified versions of publicly available databases. The modifications that have been made have been to eliminate data elements that are not needed for the earthquake loss estimation methodology. The second type of default database consists of data aggregated on a county or census tract scale. Examples are building stock square footage for each census tract and census data. These default databases are also derived from publicly available data, eliminating fields of data that are not needed for the methodology.

The databases are stored on the **HAZUS** CD-ROM. When you aggregate a region, **HAZUS** extracts only those portions of the databases that are relevant to your region. You can then access these region specific default databases and update them with

improved information that you have obtained. Displaying and modifying inventories is discussed in Chapter 7.

Appendix D gives details about the structure of the default databases and their original sources. Following is a list of default inventory information currently supplied with **HAZUS**:

Demographic Data

- Population Distribution
- Age Distribution
- Ethnicity
- Income Levels

General Building Stock

- Square Footage of Occupancy Classes for Each Census Tract

Essential Facilities

- Medical Care Facilities
- Emergency Response Facilities (fire stations, police stations, EOCs)
- Schools

High Potential Loss Facilities

- Dams
- Nuclear Power Plants
- Military Installations

Facilities Containing Hazardous Materials

Transportation Lifelines

- Highway Segments, Bridges and Tunnels
- Railroad Tracks, Bridges, Tunnels and Facilities
- Light Rail Tracks, Bridges, Tunnels and Facilities
- Bus Facilities
- Port Facilities
- Ferry Facilities
- Airports Facilities and Runways

Utility Lifelines

Potable Water Facilities and Pipelines
Potable Water Distribution Lines
Waste Water Facilities and Pipelines
Waste Water Distribution Lines
Oil Facilities and Pipelines
Natural Gas Facilities and Pipelines
Natural Gas Distribution Lines
Electric Power Facilities
Electric Power Distribution Lines
Communication Facilities
Communication Distribution Lines

3.5.2 Default Parameters

In addition to default databases, the user is supplied with default parameters documented throughout the Technical Manual. In many cases these parameters are defined on a national basis without adjustments for regional variations. In other cases such as with repair costs, regional variations are included. Examples of default parameters are costs per square foot to repair a structure, percent of residences that are owner occupied, and casualty rates for specific building types experiencing different damage states. Default relationships between occupancy classes and building types are provided to infer building inventory characteristics. Fragility curves (used for estimating damage) with default means and variances are supplied for each model building type. The user can modify all of the parameters if better information is available. Modifying default parameters is discussed in Chapters 4 through 8.

3.5.3 Viewing Default Parameters

To view the default classes, use the **Analysis|Parameters|Default|Classes** menu. This window gives you the option to view and change default classes for transportation lifelines, utility lifelines, essential facilities and high potential loss facilities. For example, for health care facilities the default occupancy is EFHM (hospital with 50 to 150 beds). If you want to change the default to EFHS (hospital with less than 50 beds), you would use this window.